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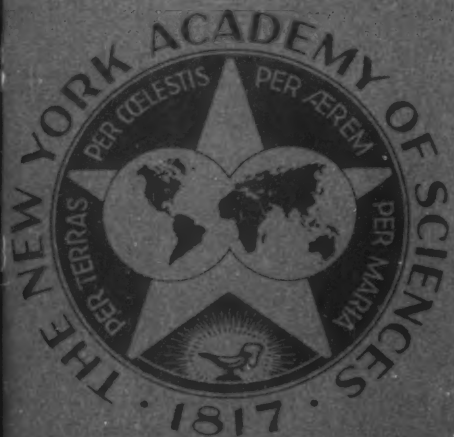

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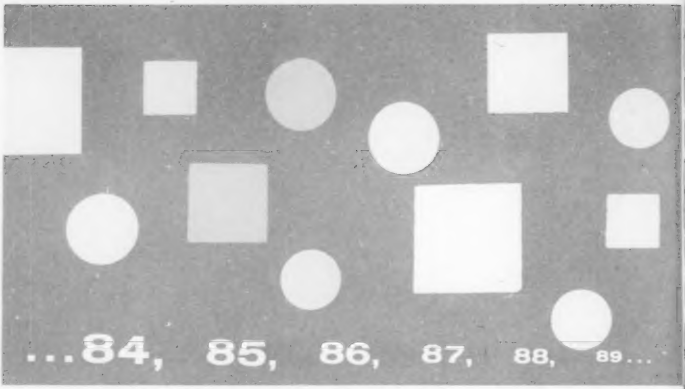


DETERMINATIONS OF PARTICLE SIZES and number are essential procedures in many biological and medical studies. Bacterial contamination is reckoned by germ count, air pollution is measured by the size and number of microscopic particles, a number of diseases are diagnosed by means of blood counts, and male fertility is determined in part by the sperm count.

Drs. Sheldon S. Segal and Kenneth A. Laurence, of the Population Council, The Rockefeller Institute, told The Academy's Conference on Applications and Methods of Counting and Sizing in Medicine and Biology that the volume of human sperm has a normal range of 33.6 to 78.4 cubic microns (a micron is approximately 1/25,000th of an inch). A decrease in sperm volume, size number, and motility can reduce fertility.

To study the volume of sperm cells, an electronic counter is used, which operates on the basis of changes in electrical conductivity. The fluid containing the particles is channelled through a small aperture. An electric current is passed through the fluid, and as the particles move through the aperture they change the electrical conductivity of the system. This change in electrical resistance is translated automatically by the unit as a count of the number of particles. The unit operates most efficiently when a fluid of high resistance contains particles of low resistance or vice versa.

The value of such counting procedures is that, even when the

counting might be done by the human eye and a microscope, the automated procedure is very much faster. In addition, it is also quite accurate in the situations where it applies. According to George Brecher and his associates, of the National Institutes of Health, determinations of the blood's red cells are reproducible within a limit of variation of only four per cent when the electronic counter is used.

One of the main problems in the use of automatic counting devices is that they do not necessarily recognize patterns that complicate the counting procedure. In scanning techniques, for instance, the process is very much like a television set in operation. An individual cell would be recognized for what it is – but two cells, one partially obscuring the other, might be counted as only one. The major line of research in this area is to improve the pattern recognition of the system.

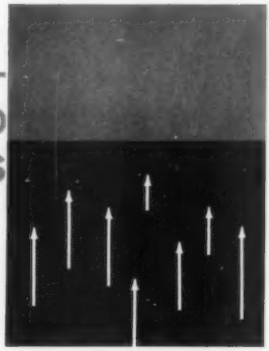
Paul V. C. Hough, of Brookhaven National Laboratory, Upton, L. I., N. Y., reported advances in the design of a scanning technique capable of analyzing the images of bubble chambers. These chambers are used to track the path of charged particles in atomic research. A computer is electronically linked to the scanning apparatus to record the positions of the bubble images that make up the track. The recognition of the pattern to be studied is determined by a human who in turn "informs" the computer; but one of the goals of this work is to enable the computer to recognize the characteristic patterns without help from the overseer.

H. P. Mansberg, of the Airborne Instruments Laboratory, Deer Park, L. I., N. Y., and J. M. Segarra, Veterans Administration Hospital, Boston, have been using a scanning device and microscope to examine brain cells. In many studies of brain tissue, the authors said, it is desirable to have accurate neuron-cell counts from large sections of the brain. In order to do this visually, many slides of very small areas have to be counted individually. This sort of work must frequently be abandoned because it is impossible to count enough small areas to give a statistically valid indication of the number of cells in the larger region. The authors' method of using a scanning counter means that they can study slides at a rate of about 4,000 in a week or less.

J. W. Hastings, of the University of Illinois, Urbana, and his associates are working with a counter to determine the size and number of various marine unicellular organisms. These organisms are

the direct or indirect food of all forms of animal life in the sea. Not much is known about their distribution, the fluctuations in the density of their population, and the ecological relationships of one type to another. A simple, rapid counting method could greatly increase our knowledge of them. □ □

WATER DESALTING—PROMISE AND PROBLEMS



PROVISION OF AN ADEQUATE SUPPLY of fresh water is one of the world's most serious problems. Government sources in the United States estimate that Americans last year used 323 billion gallons of water daily, whereas the total dependable supply was only 315 billion gallons. In 20 years the demand for fresh water is expected to triple, but the available supply, it is estimated, will be only 515 billion gallons daily.

To meet the problem, increasing efforts are being made to find cheaper, more effective ways of converting sea water. According to UNESCO, 17 nations were actively engaged in 1958 in research on demineralizing saline water. In the United States, passage of the Saline Water Act in 1952, followed by increasing Government subsidies for research, has encouraged many firms to seek improved and economical desalting methods.

In a paper to The Academy's Division of Engineering, John W. Colton, of the Scientific Design Co., Inc., noted that the Office of Saline Water of the Department of Interior had awarded research contracts to 46 firms working on many different approaches.

The earliest, and still most efficient, process for converting sea water is nature's distillation method, which uses the sun's energy to evaporate fresh water from the oceans, leaving behind the non-

volatile salts, and precipitate it in the form of rain or snow on the land surfaces of the Earth.

This principle has been used by man for hundreds of years. Writing in *Science,* Dr. W. S. Gillam, chief of the division of research of the Office of Saline Water, and J. W. McCutchan, associate professor of engineering, University of California, Los Angeles, assert that "no matter how new the design of the process equipment, the fact that it is based on distillation places it in the category of development rather than that of basic research."

Distillation covers several methods.

In single-state distillation, saline water is evaporated in a closed vessel by introduction of heat and the water vapor is condensed by being passed over tubes through which cooling water is circulated.

The process is not very efficient. Gillam and McCutchan note that it utilizes "approximately 1000 times the theoretical minimum energy requirement." According to Colton, if the heat used in single state evaporation (8,100,000 B.T.U. per 1000 gallons, introduced at a temperature of 213°) "were used to drive a turbine . . . it could generate 575 kwh. of power," whereas the minimum energy required to separate pure water from ocean water has been calculated at not quite 3 kwh. per thousand gallons.

The multiple-effect distillation process is much more efficient, since it re-uses the heat.

In the "long-tube vertical" system, salt water falls by gravity inside thin pipes heated on the outside by steam, which then condenses and forms the product water. Meanwhile, part of the water in the pipes evaporates, the rest carries off the salt. The steam generated in this stage heats the outside of the pipes in the next stage, and the process is repeated.

Flash, or multi-stage, distillation utilizes heat under pressure in a counter-flow heat exchange system. The salt water is heated before entering a series of low-pressure flash chambers – as many as 40 – by heat exchange with steam. As it enters the first chamber, part of the saline water is converted into steam which is condensed by cool pipes near the ceiling and falls into a distillate drop tray. The saline water passes on to the succeeding chambers where the process is repeated.

Other promising processes that are being studied are freezing and electrodialysis.

In freezing, ice is formed in saline water at about 32°F. Theoretically, this should produce potable water. Actually, brine is trapped

between the interstices of the ice crystallites and also adsorbed on their surfaces. The problem is to find an economically feasible method of separating the brine from the ice crystals.

Several satisfactory methods have been reported. One, described in *Scientific American,* utilizes propane which is mixed with sea water and cooled to 35°F. Hydrate crystals form and the resultant heat is absorbed by excess propane which vaporizes. After being washed free of salt, the crystals pass to a decomposing chamber into which the vaporized propane also is pumped. The propane condenses, releasing heat which melts the hydrate crystals. The pure water and the propane are separated as they flow out of the chamber.

The electrodialysis process is based on the fact that salts dissolved in water split into ions. Two types of membranes, stacked in alternate layers, are used. One screens out negative ions; the other, the positive ions. As the membranes trap the ions that cannot penetrate them, the spaces between the membranes fill up with fresh water which is then drawn off.

The advantage of electrodialysis over distillation is that the energy consumed is proportional to the amount of salts removed. Potable water, meeting the U. S. Public Health Service standard of 500 parts of salts per million parts of water, can be produced by electrodialysis from saline water containing up to 3000 parts per million at a saving in energy over the distillation process.

Research in all these methods encompasses many problems.

Those that exist in connection with designing new equipment, according to Gillam and McCutchan, are the elimination or control of scale forming on cooling or heating surfaces; use of corrosion resistant and economically feasible material; development of means of raising the level of operating temperatures in order to improve fuel economy; and development of equipment design that would produce greatest possible vapor transfer. These, they say, are "not new problems, but a new research point of view may be necessary for their solution."

The overall problem is the production of pure water at the lowest possible cost. According to Gillam and McCutchan, "only through continued basic research can man hope to approach the theoretical minimum energy requirement of 2.89 kwh. per 1000 gallons." Al-

though it is estimated that a minimum of "about four times this figure is all we can hope for," they add, "processes in operation today require many times this amount of energy. Energy represents half the cost of producing fresh water in most conversion processes. But "even if energy were free," say Gillam and McCutchan, "the cost of converting water with present equipment might still be too high."

The answer may lie in other sources of energy, such as solar heat or nuclear reactors. □□

WANDERING TREE PATHOGENS

AMONG THE MOST destructive enemies of trees are fire, man, insects, animals and disease. According to estimates of the U. S. Department of Agriculture, disease is responsible for approximately 45 per cent of all tree losses.

The critical nature of the rate of loss of the world's forests has caused the International Union of Forest Research Organizations to project a program of international cooperation which includes research in tree diseases and quarantine measures.

"Epidemic diseases are much more serious for forest trees than for comparable agricultural crops," according to Professor A. J. Riker, the University of Wisconsin. "If a field of wheat should be destroyed, something else could be planted the next year. But if trees are damaged, then 10, 25, or 50 years of productivity of the land may be reduced or lost."

Many of the pathogenic agents that destroy foliage, kill trees and cause root, butt and trunk rot are world travelers. Modern air transport increases the chances of distributing these pathogens from

one country to another. Plant quarantines are the accepted bulwark against entry of dangerous tree diseases. Suggestions have been made that forest pathologists could greatly strengthen such measures by supplying quarantine officials with a list of the most dangerous pathogens and descriptions by which they may be identified.

Pathogens with known records of destruction are not the only bearers of disease. Those that are seemingly innocuous in one country may become highly virulent in other lands. Professor Riker noted in *Unasylva* that chestnut blight was considered of no consequence in East Asia, but when it reached America it practically eliminated the American chestnut. To avoid such situations in the future he recommended "experimental plantings" to predetermine a pathogen's reactions to environmental changes.

In the U. S. Department of Agriculture Handbook No. 139, Dr. P. Spaulding has listed 33 American forest-tree diseases, and their causal agents, that are potentially dangerous to forests of foreign countries.

Available data on epidemic diseases and their importance in each country are being prepared in a number of areas. But compilation of such lists is hampered by lack of information on many diseases.

To cite just one example, A. L. Griffith, of the East African Agricultural and Forestry Research Organization, Kenya, writing in *Unasylva* on the "Dry Woodlands of Africa South of the Sahara," noted that "little or nothing is known" of the virus or fungal pests and diseases of such forests as the acacia-commiphora scrub woodlands of Kenya and the Horn of Africa; the miombo woodlands of central Africa; the Rhodesian teak woodlands; or the southern Rhodesian mopane woodlands.

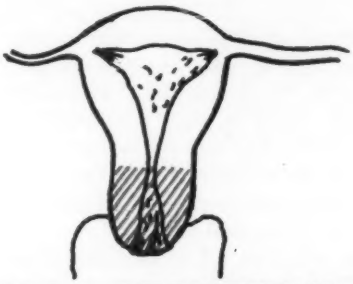
Imported pathogens, of course, are not the only source of tree disease. Professor Riker warned that pathogens causing root and butt rot "may develop in an apparently innocuous way in the nurseries" and eventually be distributed in areas used for reforestation.

The problem, however, is essentially an international one, and he has suggested that important cooperative research can be done on such topics as host ranges, alternate hosts, environmental influences, disseminating agents, seemingly innocuous pathogens, improved methods of eradication, and disease resistance.

The United States is the home of a number of rare species of trees that face the possibility of extinction. Discussing California's

"Endangered Relic Trees" in *Natural History,* Dr. Paul D. Kilburn, of Principia College, lists such examples as Torrey pine, of which only 3,000 individuals are known to exist; the Monterey cypress, which is numbered in the thousands; the desert fan palm, *Washingtonia filifera,* "which appears to be making its last stand"; and others.

Cooperative international research should aid the survival of these and other tree species. □ □



CERVICAL SECRETIONS: CANCER AND CONCEPTION

INCOMPLETE EPIDEMIOLOGIC EVIDENCE "points to coitus as a major factor in the genesis of cervical carcinoma. If this is true," Dr. Milton Terris remarked to participants in The Academy's conference on The Cervix, "the most likely explanation is that coitus provides the means for frequent contact of the cervix with a carcinogenic agent over a period of many years." At the same time, he advised that "recent investigations have reported conflicting results on the association of the disease with extramarital coitus, frequent coitus, and non-circumcision of marital partners."

Doctor Terris, of the Public Health Research Institute of the City of New York, has also found that carcinoma of the uterine cervix (the lower neck of the uterus that extends into the vaginal canal) occurs with greater frequency in low income groups, Negro and Southern white women, than in others. "It occurs more frequently in married than in single women," he said, "and is associated with early marriage and multiple marriages. A definite association with syphilis has been demonstrated, and the incidence is apparently very high in prostitutes." On the other hand, cervical carcinoma is almost

nonexistent among nuns and is uncommon among Jewish women. "The low incidence . . . in Jews," Dr. Terris said, "tends to incriminate the smegma found in uncircumsized males." Smegma is the thick, strongly-odored secretion that accumulates under the foreskin of the penis or the vaginal lips. Smegma consists largely of surface cells called squamous epithelium.

Contrary to current opinion, epidemiologic evidence does not support the theory that cervical cancer is more prevalent in women who have had numerous pregnancies. Nor is there any confirmation of an association with duration or frequency of douching. Some studies, however, Dr. Terris said, have demonstrated an association with early marriage and even more specifically with early coitus.

If a causal relationship between circumcision status and cancer of the cervix is clearly established, Dr. Terris concluded, "we shall have available a relatively simple and feasible method for reducing the future incidence of cervical cancer."

The uterine cervix is 1.5 inches long under ordinary conditions, and shrinks to about 0.5 inches during labor. The importance of the cervix rests partly in its critical physiologic role in both conception and birth, partly in the complexity of its normal biologic functions, and partly in the variety of diseases and traumatic effects to which the organ is susceptible. The conference dealt first with the structure and function of the normal cervix and with cervical secretions, especially as these indicate the state of health of the female reproductive organs and are related to estimations of fertility.

A relationship between cervical secretions and fertility appears to exist but it is not precisely known at present. In a paper, written by the late Dr. W. T. Pommerenke and read by his colleague, Dr. John C. Donovan, University of Rochester School of Medicine and Dentistry, and Strong Medical Hospital, it was stated that "the cervix with its secretions provides the transitional environment or frontier which must be negotiated by the sperm prior to its ascent into the upper female genital tract."

Several cervical mucus tests were described which have diagnostic value in investigating infertility problems and menstrual disorders. One is the "fern test" in which the crystallization patterns of dried cervical mucus are related to the cyclical activity of ovarian steroid hormones that figure in ovulation, fertilization, and implantation. Another is the Sims-Huhner test, which measures the

physical characteristics of the mucus, correlated with basal body temperature and the cellular condition of the vaginal wall. The condition of cervical secretions is one major factor in determining the time to introduce sperm in attempting artificial insemination. Dr. Alan F. Guttmacher, The Mount Sinai Hospital, New York, discussed this factor and also gave special attention to the contemporary status of artificial insemination, by which between five and seven thousand babies are born each year in the U.S. There are two types, homologous (AIH) in which the husband's semen is introduced artificially into the wife, and heterologous (AID) in which an unrelated donor's semen is used. The medical indications for either procedure, and for selecting one or the other, were spelled out in detail. Artificial insemination does not involve dangers to health; the variety of pregnancies and births achieved by this means are statistically the same as among those achieved by normal intercourse. "The procedure can give great happiness to properly selected parents," Dr. Guttmacher said.

Full responsibility for selection of a donor in AID cases lies with the physician, according to Dr. Guttmacher. The physician must explore the genetic and environmental background of the donor, and select one who has proved his health by the stature of the work he does and proved his fertility by being already married and a father. It is standard procedure to seek a donor with some general physical resemblance to the intended father, and to avoid Rh blood factor problems, but otherwise physicians avoid special qualifications. Prospective parents must abide by their physician's decisions.

Aside from the religious question, legally no law is broken in having a child by artificial insemination, since common law contains no statutes relevant to the method of conceiving. Nevertheless, and in the absence of statutes and precedents (although a number of cases have been tried), any specific decision rests on the discretion of the Court and it is possible that the child's legitimacy might be questioned, the wife might be considered an adulteress, and the physician might be liable to criminal prosecution. Until the situation is changed by due process, Dr. Guttmacher advised physicians to "forget signed papers" and "accord paternity to the husband in both the hospital record and the birth certificate."

A number of reports centered on the role of cervical muscle changes in spontaneous abortion. These changes are especially notice-

able at the critical locus known as the internal os, the mouth of the cervical canal where it opens into the uterine cavity. Drs. David N. Danforth, John C. Buckingham and Richard Seldon, Northwestern University Medical School, Evanston, Ill., reported that the processes involved in the increased dilatability of the cervix during pregnancy and its actual dilation during labor and delivery constitute a major problem for obstetricians. Studies have shown alterations in the biochemistry of cervical muscle, and increasing dissociability of muscle bundles into their component fibrils as pregnancy advances.

A number of surgical approaches to the weak or "incompetent" cervix have been tried. Dr. Robert H. Barter, George Washington University School of Medicine, Washington, D.C., reported that thigh muscle has been used to strengthen the weak cervix, and that more recently, with even greater success in preventing spontaneous abortions, dacron has been used.

Dr. A. F. Lash, University of Illinois School of Medicine, Chicago, insisted that the essential medical problem in cervical incompetence is not the frequency of the disease but the difficulty of diagnosing the condition. Even with certain simple aids to the physical examination, which he said were necessary additions, diagnosis is based primarily on the patient's history and is therefore "not positive but presumptive." Nevertheless, during a pregnancy, a suspected weak cervix must be treated. As a result, operations are sometimes performed which later prove to have been unnecessary. In some patients, Dr. Lash added, surgery may be contraindicated for other reasons. "Injudicious management may not only menace a normal pregnancy but jeopardize the patient's life," he said. A report by Drs. Warren R. Lang and Gabriel Tatarian, Jefferson Medical College, Philadelphia, Pa., noted that from the onset of menstruation, through the child-bearing years and in pregnancy, until the postmenopausal period, "both the epithelial surface and the stroma" or framework of the cervix "undergo a fairly definite series of modifications." However, not all changes that can occur are within this normal pattern.

Dr. Paul A. Younge, Harvard University School of Medicine, described what might be termed a model "normal cervix." Such a cervix, he said, seldom develops malignancy. If the characterization of the model is correct, he said, then any patient in whom a deviant cervix is detected should be placed under careful surveillance, since

slight abnormalities and especially benign lesions have a tendency to become more serious or frankly malignant.

Drs. Charles F. Geschickter and Francesca Fernandez, Georgetown University Medical Center, Washington, D.C., described a form of early abnormal growth called "unquiet epithelium." The aberrations in this surface disturbance also extend into the body of the cervix. Since it is found frequently in association with the cancerous condition known as carcinoma in situ—a kind of malignant cancer that is thought not to spread—the suggestion was made that this latter disease may actually find ways to invade adjoining levels of tissue.

There has been considerable debate on the relative value of several techniques of attempting to differentiate between carcinoma in situ and the still more dangerous, frankly malignant invasive lesions. Dr. George L. Wied, University of Chicago, and Chicago Lying-In Hospital, said that (cytologic) examination of the loose cells commonly shed from the cervical surface (exfoliated cells) is a "relatively accurate and useful additional aid in the evaluation of the case prior to therapy." He emphasized that verification by examination of tissue sections (histopathologic study of biopsy material) remained mandatory. According to Dr. Robert H. Fennel, Jr., Presbyterian Hospital, Pittsburgh, Pa., the histologic picture of cervical carcinoma in situ is the only true representative feature of the disease. Study of exfoliated cells also yields useful information, but, he stated, the diagnosis must be made at the microscopic level because "there are no clinical or gross morphologic features that allow visual identification of the lesions."

Sharp conization, in which a piece of the cervix is removed, has "the maximum diagnostic value and in certain instances may have a temporary, possibly even permanent, therapeutic effect." This view was expressed by Dr. Roger B. Scott, Western Reserve University School of Medicine, and University Hospitals of Cleveland, Ohio, who also advised that problems of this nature must be treated by the physician on an individual basis, and that the value of sharp conization depends directly on the skill and technique of clinician and pathologist.

Several contributors to the conference discussed radiation and surgical techniques in the treatment of cervical carcinoma. It was stated that chemotherapy has not proved particularly valuable in this disease. □ □

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